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(54) **Membrane separating device**

(57) A filtration or diffusion cell comprises a plurality of carrier plates (1,2) and a plurality of semi-permeable membranes for the treatment of fluids, the cell being sealed-off by string-shaped or tape-shaped sealing means for the separate guidance of the fluids. For the reception of the sealing means the carrier plates (1,2) are provided with channel grooves (13) open towards the plane of each plate and passages (11,12) in these, which communicate at least sectionwise and receive a sealing substance (15) introduced in flowable state for solidification therein. The carrier plates (1,2) are connected through the sealing substance (15) into a cassette-shaped unit so as to form the actual separating device. In the case of carrier plates (1,2) of square plan, the front side and the rear side of each membrane is flowed over crosswise.

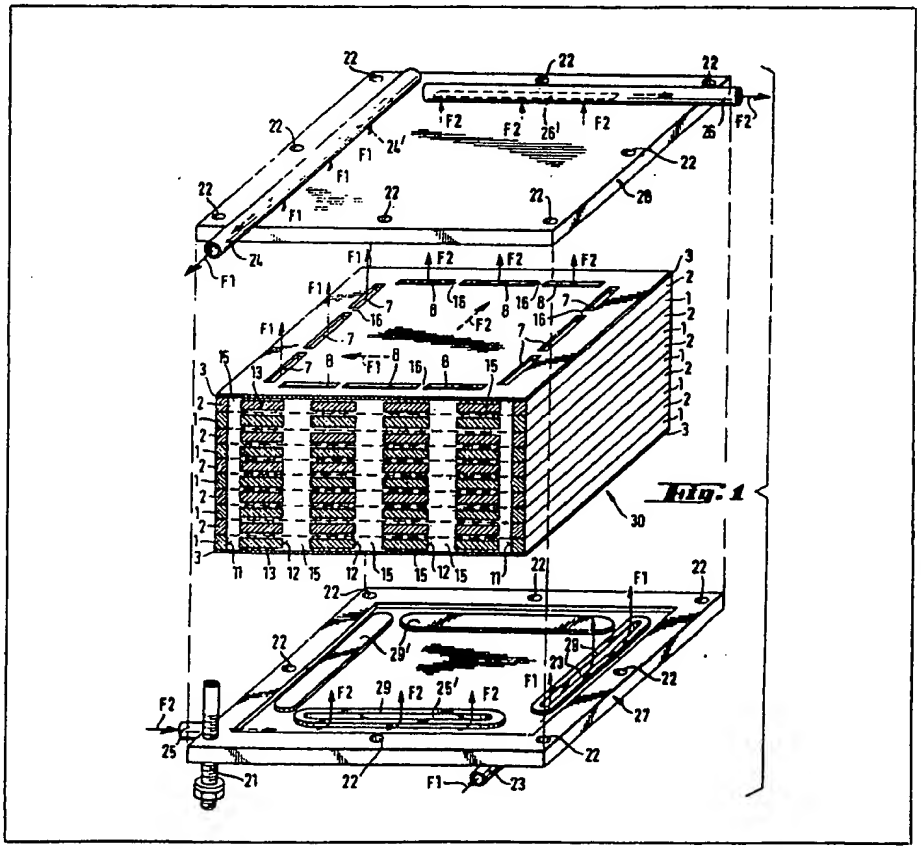

Fig. 1

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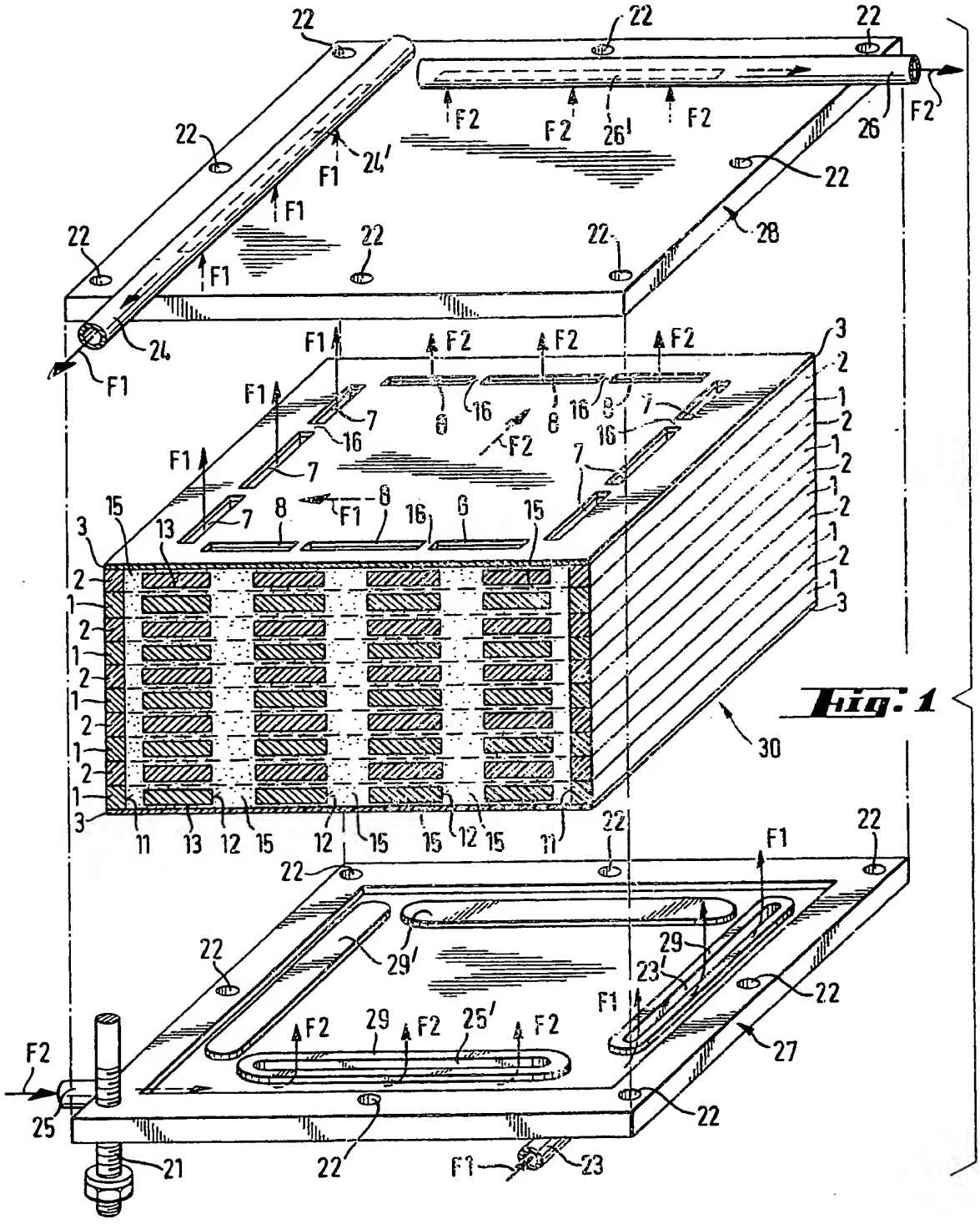
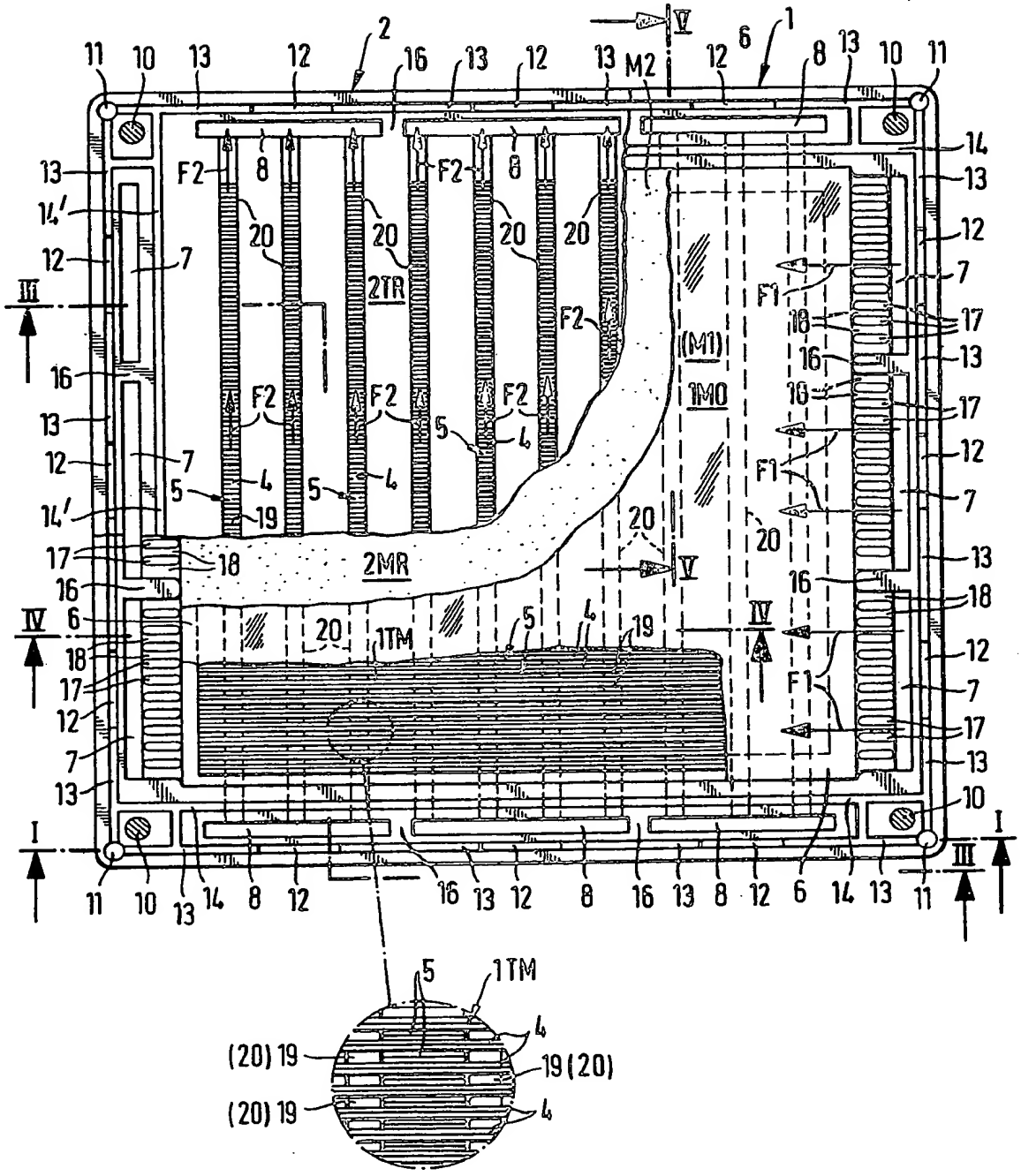


Fig. 1

Fig. 2


V
2
1
6
M2
F2
F1
8
20
2TR
(M1)
1MO
2MR
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5
4
19
18
16
17
14
14'
13
12
7
10
11
I
III
IV
(20) 19
19 (20)

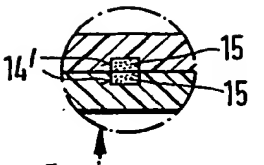


Fig. 3

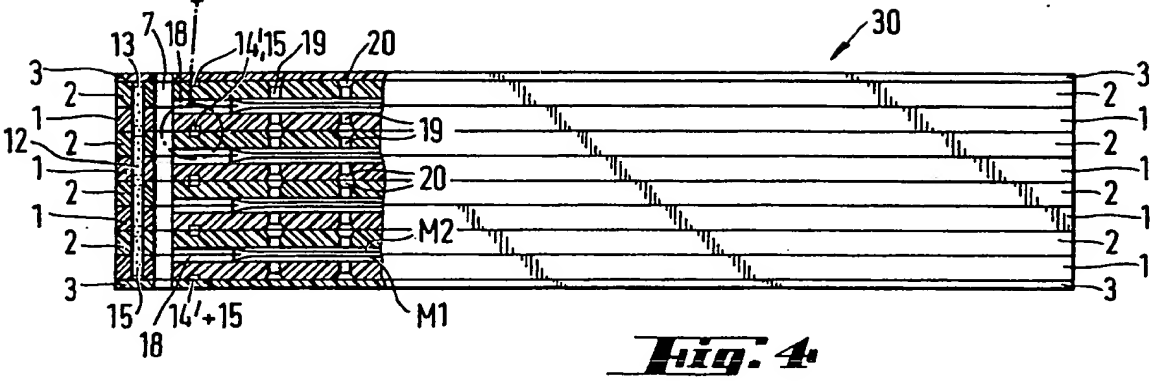
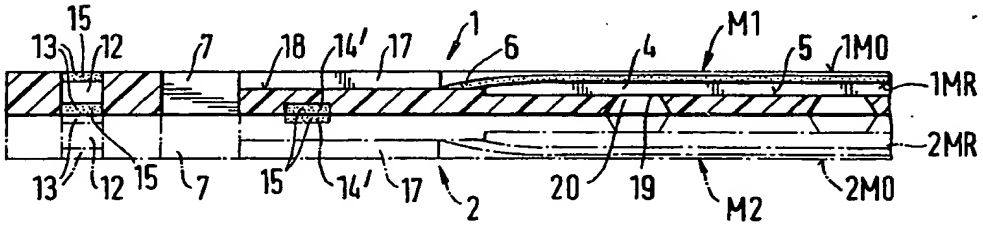


Fig. 4



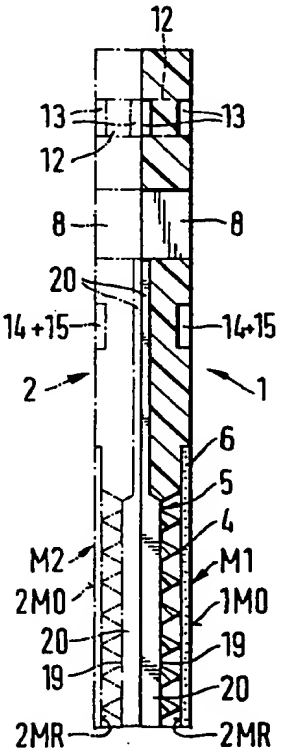
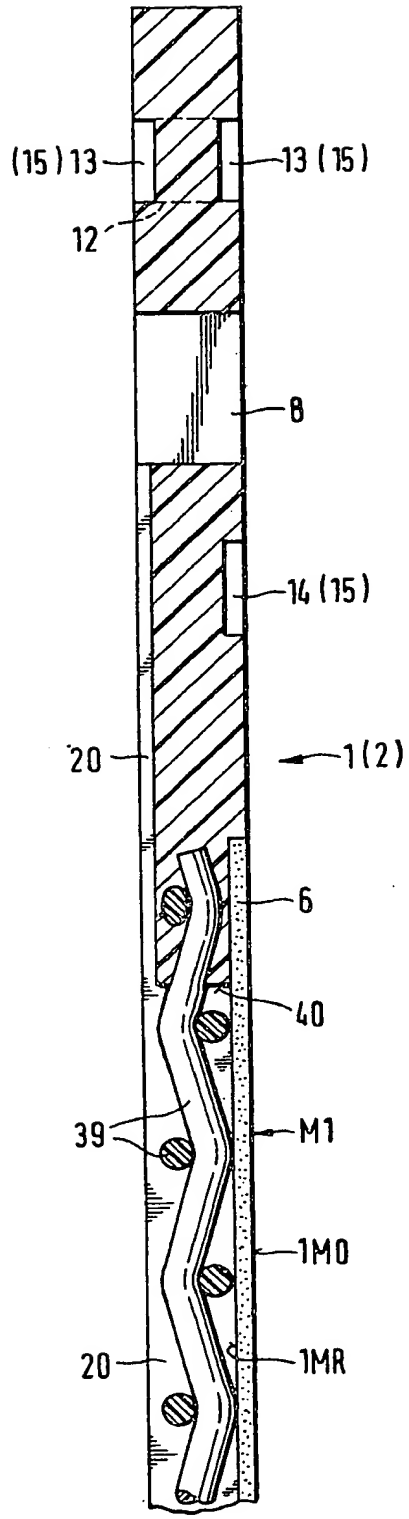


Fig. 5

Fig. 6



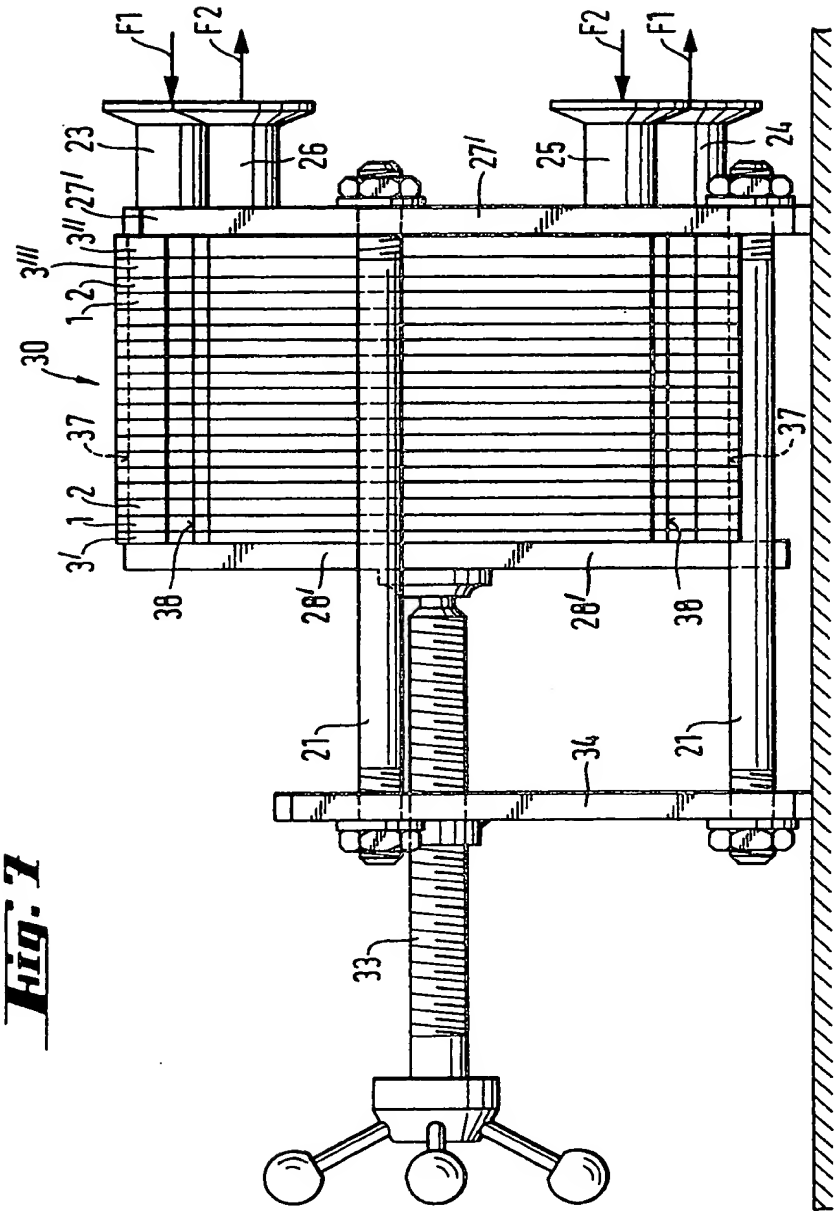


Fig. 1

Fig. 8

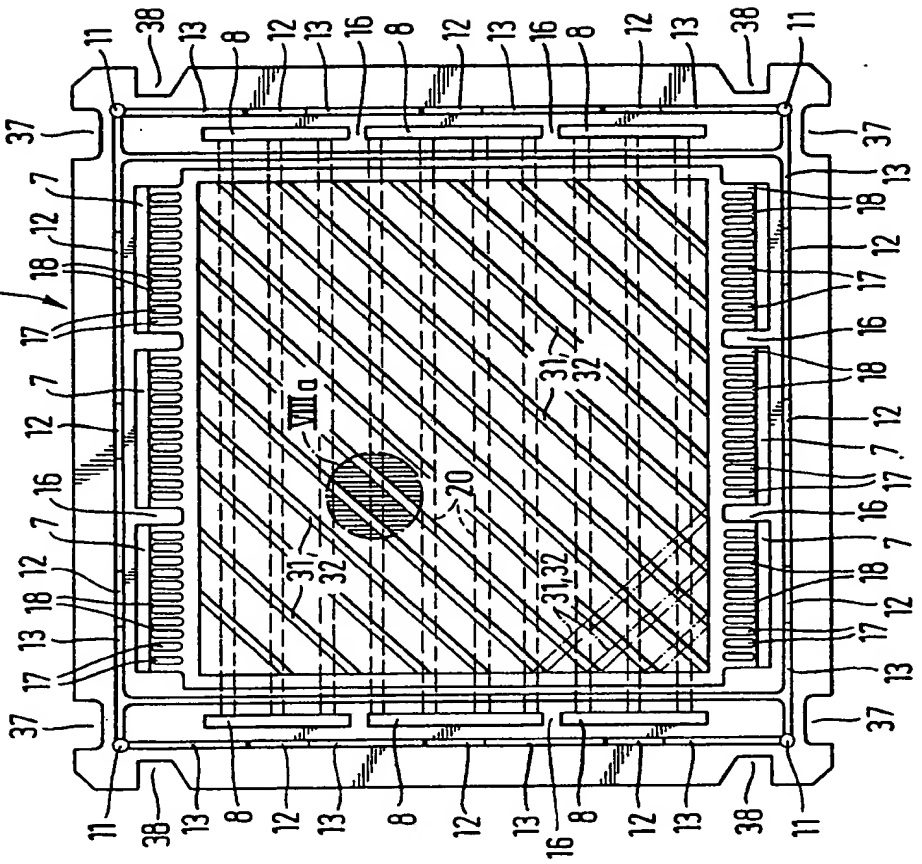
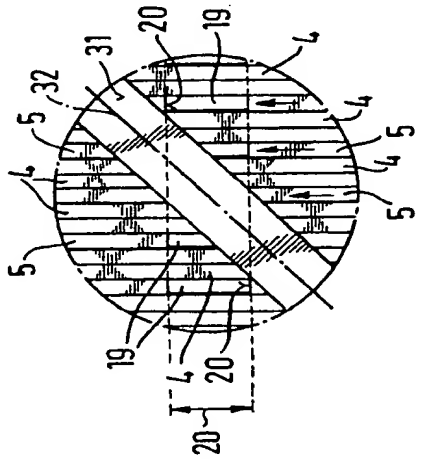


Fig. 8a



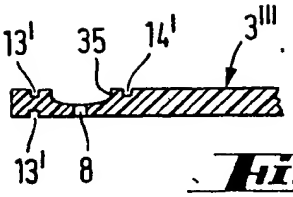
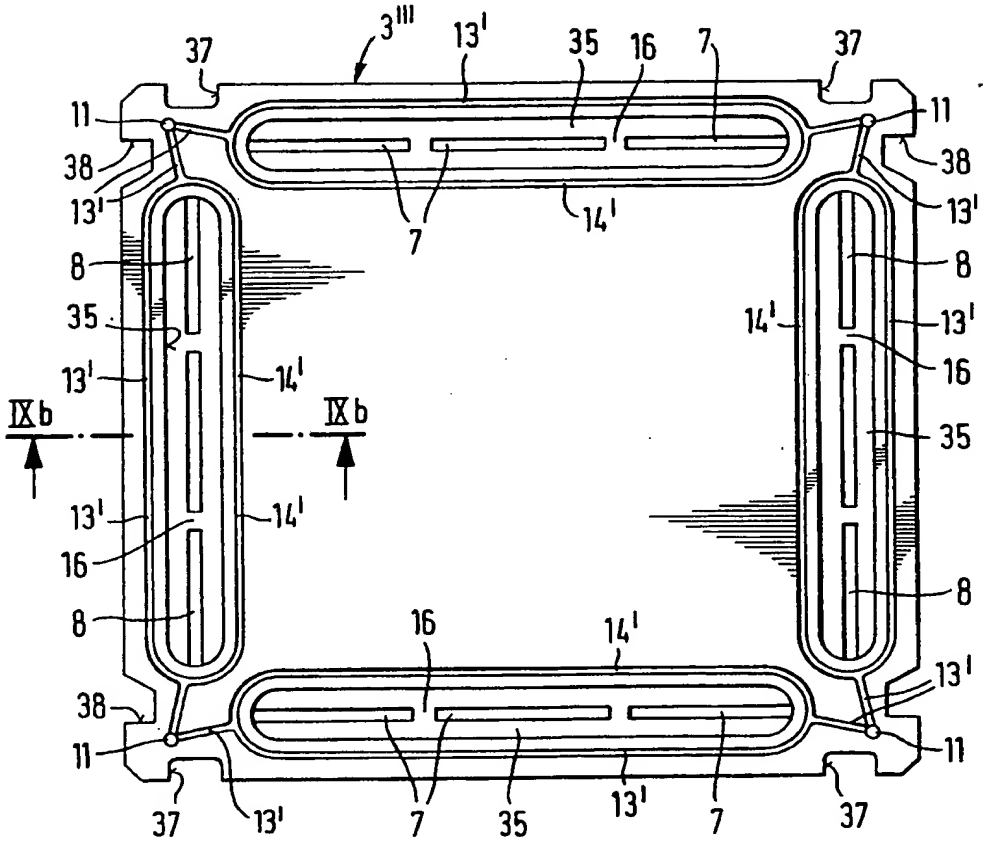


Fig. 9b

Fig. 9a



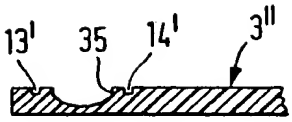
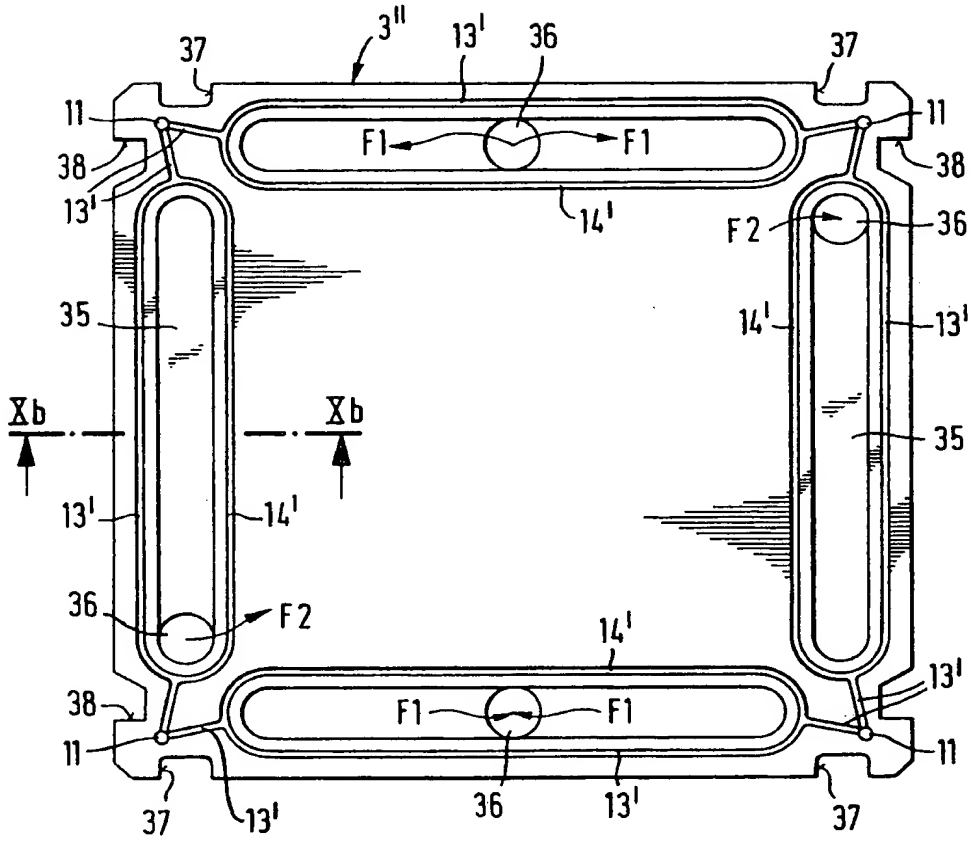


Fig. 10b

Fig. 10a



SPECIFICATION

Separating device

The present invention relates to a separating device and has particular reference to device comprising carrier plates and semipermeable membranes for treatment of fluids conducted in separate flow paths. A number of separating devices of various kinds are known in the art.

Carrier plates of plastics material, which are covered over their entire area by membrane blanks, are used in a known separating device described in DE-GM 70 22 655. Arranged on each carrier plate in the region of the outside edge, for the separation of the different flow paths and for the overall sealing of the flow chambers, are thin sealing ribs which in consequence of the contact pressure press into the microporous membrane structure. The membrane takes over the actual sealing function in the region of the sealing rib. This manner of the sealing is unsatisfactory insofar as a planar, parallel construction of the plates and sealing ribs is not possible due to production tolerances and the membrane must have a certain thickness in order that it can have a sealing function. According to the intended use of the separating device, for example for dialysis, ultrafiltration or reverse osmosis, and according to the kind of the fluids to be treated, for example liquids or gases, special membranes must be selected in order that an optimum substance separation is possible. It is therefore known, for improved sealing, to include special sealing plates between the individual layers of the carrier plates in addition to the carrier plates (DE-AS 22 09 116 / US-PS 3 831 763), wherein the sealing frames are flat blanks of a special sealing material. The special sealing material must, just as the membrane and the plates of plastics material, be able to be treated several times in an autoclave, so that not all sealing materials are suitable for all applications and for all purposes of use of the separating device. The carrier plates of plastics material must have a certain thickness in order that they do not distort when treated in an autoclave and withstand the tightening forces of the entire device. The additionally necessary sealing frames increase the overall constructional size of such a packet-shaped separating device and represent additional danger points for the occurrence of leakage. A separating device disclosed in DE-OS 29 30 986 therefore embodies sealing by sealing ribs formed into the carrier plates. Such a sealing causes difficulties in the region of the inlets and outlets, which are mostly formed as circular bores and which pass through the entire stack of carrier plates to change into horizontal subdividing channels.

It is also known (US-PS 3 585 131) to provide in the carrier plates slot passages which extend over the entire width of the membrane surface flowed over in order to provide a better distribution of the fluid currents. In this known separating device, the membrane consists of interwoven hollow fibre membranes through which flow takes place crosswise and perpendicularly. The fabric-like membrane is sealed by a plastics material adhesive substance bead for the separation of the three fluid spaces against the carrier plates. In this case, as well, the construction and the mode of sealing is very expensive in terms of manufacture. Through the fabric-like structure, the danger also exists that the sealing material does not fully penetrate into the interstices of the fabric so as to enclose the individual hollow fibre membrames at all sides and seal them off from the carrier plates.

In departure from the use of inherently stiff carrier plates, it is also known to form separating elements in several layers from a plastics material fabric, a fleece-like carrier material arranged on both sides and membranes arranged at both sides. The sealing of the individual separating units takes place in that the entire outside edge of the separating element is encased in cast plastics resin. The distribution of the fluid currents within the separating elements takes place through bores arranged at a spacing at the edges, wherein for the separation of the fluid paths from each other the adjacent bores are alternately connected externally and internally with the sealed-off outside edges through an arcuate seal of plastics resin (DE-OS 29 20 253 / US-Serial No. 906 922). This kind of the sealing, too, is unreliable since it largely depends on controlling and exactly delimiting the depth of penetration of the resin into the individual layers of the separating element.

Other separating devices are described in US-PS 4 113 625, DE-OS 29 30 986, GB-PS 329 235, US-PS 3 497 423, DE-OS 23 04 644, DE-OS 22 05 294 and DE-OS 29 022 247, from which different geometric shapes of the separating elements, sealing elements and carrier plates are known.

There is accordingly a need for a separating device which is composed of a plurality of individual elements, has a large effective membrane surface and which in spite of the plurality of individual separating elements makes possible a simple and reliable sealing of the flow paths to be separated and permits a guidance of the fluids in a manner favourable to flow and good utilisation and flowing-over of the membrane surfaces.

According to the present invention there is provided a separating device comprising a plurality of semipermeable membranes and a plurality of carrier plates retaining the membranes and defining separate flow paths for the passage of two fluids through the device each in contact with a respective one of the

sides of each membrane, the plates being provided with channels in their major surfaces and with openings placing the channels of the plates in communication at least in sections, the channels and openings being filled with a solidified sealing substance sealing each flow path from the other, and being so arranged that the sealing substance is introducible in liquid state so as to solidify in situ.

In a preferred embodiment, the plates have channel grooves, which are open towards the plane of the plate for the reception of the sealing elements, and openings in these, which communicate at least in sections and receive the sealing material introduced in flowable state and rigidifying therein. The geometric shape of the carrier plates, the manner of the flow guidance of the fluids and the thereby necessary arrangement of sealing elements are to a certain degree interdependent from the viewpoint of achieving optimum separating performance, optimum sealing function and optimum production.

Embodiments of the present invention will now be more particularly described by way of example and with reference to the accompanying drawings, in which:—

Figure 1 is an exploded perspective view of the entire separating device according to one embodiment of the invention, with individual separating elements, which are connected into a block or parallelepiped, being shown in section along the line I–I of Fig. 2,

Figure 2 is a partly broken away plan view of two identical carrier plates, lying one on the other, and membranes of the device of Fig. 1, partially as detail from front and rear side,

Figure 3 is a cross-sectional view of a stack of carrier plates and membranes along the line III–III of Fig. 2,

Figure 4 is a partial cross-sectional view of a carrier plate and membrane along the line IV–IV of Fig. 2,

Figure 5 is a partial longitudinal sectional view of a carrier plate and membrane along the line V–V of Fig. 2,

Figure 6 is a view similar to Fig. 5, but of a modified carrier plate with a supporting element of fabric,

Figure 7 is a side elevation of a separating device according to another embodiment of the invention,

Figure 8 is a plan view of a modified carrier plate from the membrane side,

Figure 8a is a detail, to an enlarged scale, of the carrier plate of Fig. 8,

Figures 9a and 10a are plan views of, respectively, two closure plates of the separating device of Fig. 7, and

Figures 9b and 10b are sectional details of Figs. 9a and 10a, respectively.

Referring now to the drawings, there is shown a separating device constructed from idential carrier plates which, in order to facilitate identification, are however designated as carrier plate 1 and carrier plate 2. According to Fig. 2, each carrier plate 1 or 2 has a substantially rectangular plan and rectangular cross-section. The carrier plates 1 and 2 at all four sides of the rectangle have several slot passages 7 and 8, which are interrupted for reasons of strength merely by connecting webs 16. These connecting webs 16 can, however, be dispensed with in the case of smaller constructions of the carrier plates. The slot passages 7 and 8 each end in the region of the outside edges of membranes M1 and M2 so that a fluid current guided in the passages 7 and 8 can brush over the membranes M1 and M2 over their entire width in a manner favourable to flow. The carrier plate 1 is shown in Fig. 2 from the membrane side and this side is designated by 1TM. The membrane side of each carrier plate 1 or 2 has support elements 4 and flow channels 5. According to Fig. 5, these are formed by grooves and webs which are prism-shaped in cross-section, wherein the grooves from the flow channels 5 and the ridges of the webs form the support elements 4 for the membranes. The grooves 5 are provided in their base with passages 19 arranged at longitudinal spacings, the passages 19 facing towards the opposite side of the respective carrier plate 1 or 2 and being widened on the opposite side into collecting grooves 20, which extend transversely to the grooves 5 and end in the passages 8 for a second fluid F2. The individual membrane blanks are sealingly connected around their edge regions 6 in a kind of trough of the carrier plates through welding or cementing. Provided in the region between the membrane edges 6 and the slot passages 7 are spacer members 17 and gates 18, which on the one hand enable a first fluid F1 to flow out of the passages 7 through the gates 18 over the membrane surface 1MO in the direction of the oppositely disposed passages 7, and on the other hand ensure that the superposed carrier plates receive adequate planar parallel support among one another through the spacer members 17. In like manner, the rear side of each carrier plate is interrupted in substantially plane parallel manner by the collecting grooves 20 shown at 2TR of the carrier plate 2. The rear sides of the carrier plates 1 and 2 thus support each other over a large area.

For the separate guidance of the two fluids F1 and F2, each carrier plate has passages 11 at at least two oppositely disposed corners. In the present example, passages 11 are provided at all four corners. These mutually oppositely disposed passages 11 are connected through cross channels 13 extending in both directions. These are arranged at both sides of the carrier plates. It is sufficient, however, if the cross channels 13 are provided on only one side, as it is secured through the layering

of the carrier plates that a circulating cross channel 13 is arranged between each two carrier plates 1 and 2. Additionally associated with the cross channels 13 and distributed over their length are further passages 12, which are disposed one above the other and pass through all carrier plates 1 and 2 in the manner of a shaft (Fig. 3). These passages 11 and 12 and the cross channels 13 serve for the reception of sealing means 15 in order to seal off the entire outside region and to provide permanent interconnection of the stacked carrier plates 1 and 2.

For sealing of the fluid space for the separate guidance of the fluid F1 relative to the fluid F2, a respective groove 14 is provided at each of the two oppositely disposed sides of the rectangle parallel to the flow channels 5 outside the edge region 6 of the membrane M1, which grooves communicate with the cross channels 13 and/or the passages 11 and 12. Both grooves 14 are arranged only on that membrane carrier side of the carrier plates 1 and 2 which is designated by 1TM in Fig. 2. Provided on the rear side of the two other oppositely disposed rectangle sides of the carrier plates 1 and 2 are two corresponding grooves 14', which extend parallelly to the collecting grooves 20 and communicate with the cross channels 13 and/or the passages 11 and 12. The grooves 14' are filled with the sealing means 15, as is later described. As a result, it is secured that although the permeate issuing on the rear side of the membrane passes through the passages 19 of the carrier plates 1 and 2 and can enter from the collecting grooves 20 into the slot passages 8, it cannot enter the slot passages 7 which guide the first fluid F1. The rear side of the membranes is designated in Fig. 2 by 2MR for the membrane 2.

Additionally, openings for assembly tighteners 10, which during assembly serve as guidance for the carrier plates 1 and 2 to be stacked one on the other, are provided in the carrier plates at least in the four corner regions.

The carrier plates 1 and 2 provided with the membrane blanks M1 and M2 are strung onto the assembly tighteners 10 in pairs with the membranes lying one on the other, as indicated in Fig. 3, and are united into a stack of ten or twenty carrier plates. With the aid of the assembly tighteners 10 and pressure means (not shown), the stacked carrier plates 1 and 2 are firmly pressed against each other. All the undepressed surfaces of the carrier plates in that case rest in planar, parallel manner on the counter-surfaces of the other carrier plates. In this pre-assembled state, the sealing medium 15 of a flowable synthetic resin, adhesive substance or a thermoplastic plastics material is injected into the passages 11. The injection can take place, for example, according to Fig. 2 into the lower left passage 11. If the stack of carrier plates 1 and 2 is erected in such a manner that the diagonal of the two oppositely disposed passages 11 extends vertically, then the injected sealing medium 15 rises in both directions in the cross channels 13 and the grooves 14, 14' in the direction of the highest disposed passage 11 and in that case through displacement of the enclosed air fills out the hollow spaces formed by the passages 11, the cross channels 13 and the grooves 14 and 14'. Since a plastics material, synthetic resin and/or adhesive substance, which is flowable during the processing time but hardenable thermally and/or in time, is used as the sealing medium 15, after the solidifying of the sealing medium 15, a permanent, tight interconnection of the individual carrier plates 1 and 2 is provided so that after the removal of the assembly tighteners 10, a packet-shaped or parallelepipedonal separating device 30 according to Fig. 1 results, which as a block can be sealingly clamped between two end plates 27 and 28.

To accelerate the filling of the cross channels 13 and the grooves 14 and 14' and to obtain an even better interengagement of the carrier plates 1 and 2 over the entire periphery, further passages 12 are provided in the region of the cross channels 13 and, according to Fig. 1, receive the sealing medium 15 in continuous columns.

In the simplest embodiment, the stack of carrier plates 1 and 2 is closed off by the rear side of such a carrier plate. The outermost blank is in that case protected against physical damage by the rear side of the respective outer carrier plate.

For the reception of such a unit, sealing rings 29 are provided on the two end plates 27 and 28 for sealing connection therewith.

If the outer carrier plates receive an additional protection of the membrane blanks, then this can be effected by, for example, an unprofiled, planar closure plate 3 on each side of the parallelepiped 30. The closure plates 3 have corresponding slot passages 7 and 8, as illustrated in Fig. 1. The closure plates 3 can themselves, however, be constructed as flat seals, i.e. they have a certain permanently resilient effect, and can take over the sealing function between the packet-shaped separating device 30 and the two end plates 27 and 28 so that specific ring seals 29 are not necessary.

According to Fig. 1, both the end plates 27 and 28 are somewhat larger in terms of area and preferably consist of fine steel, the end plates being provided in the edge regions with several bolt holes 22 which receive tightening elements 21. The lower end plate 27 for the introduction of the first fluid F1 has a tubular main connection 23 which is associated with the passages 7, arranged on the righthand side, of the carrier plates 1 and 2, the connection 23 having a main connecting slot 23'

which ends on the upper side of the lower end plate 27. Provided in the oppositely disposed edge region of the upper end plate 28 is a corresponding main connection 24 with a correspondingly arranged main connecting slot 24', which in the illustrated example serves as an outlet for the first fluid F1. The first fluid F1 entering into the main connection 23 thus fills the passages 7, flows over the membrane blanks in the individual planes and enters into the oppositely disposed passages 7 and issues out through the upper main connection 24. A flow in reverse direction is, of course, also possible. Should the second fluid F2 flow over the rear side of the membrane on the principle of diffusion, then the arrangement of two further main connections 25 and 26 in both the end plates 27 and 28 is provided in appropriate sense for the fluid F2. The fluid F2 enters into the lower end plate 27 through the main connection 25 via the main slot connection 25' and from there into the passages 8. The rear sides of the membrane blanks are flowed over in appropriate sense and the fluid F2 enters into the oppositely disposed passages 8 and from there into the main connection slot 26' and the main connection 26. In this case as well, a reverse flow direction is possible.

The main slot passages 23', 25'. 24' and 26' can, as indicated in Fig. 1, be equipped with ring seals or other flat seals 29 if a special sealing is not provided on the upper and lower sides of the separating device 30. Corresponding seals 29' must then be provided in the region of the blind connections for the other passages 7 and 8.

For the performance of ultrafiltration, only a main connection, i.e. either the main connection 25 or the main connection 26, is actually necessary for the fluid F2. Since the permeate must not flow over the rear side of the membrane blanks, but must only be withdrawn from the entire surface, it is also only necessary to provide slot passages 8 at the third or fourth side of the rectangle. In order from the outset to ensure a comprehensive application by the carrier plates 1 and 2, these are constructed to be flowed over at both sides. It is of advantage in the case of ultrafiltration if the permeate is withdrawn in both directions from the rear side of the membrane blanks.

The carrier plates 1 and 2 are for reasons of costs formed of plastics material. They can, of course, also be formed from fine steel for particular purposes of use.

The carrier plates 1 and 2 according to Figs. 2 to 5 and 8 are particularly suitable for filtration. For the performance of separating processes according to the principle of diffusion, carrier plates as indicated in Fig. 6 are more suitable. In the case of a substance exchange on the principle of diffusion, it is advantageous if the second active fluid F2 comes into contact with the largest possible area of the membrane on the rear side thereof. Suitable for this purpose is, for example, a fabric 39, which supports the membrane M1 and is fastened in a frame-like window 40 of the carrier plate 1. This can take place in such a manner that the fabric 39 is integrated into the frame of the carrier plate 1 through thermoplastic deformation of a projection in the window 40 and also the membrane outside edge 6 is located in this region. Otherwise, the construction of the carrier plate corresponds to the details illustrated in Figs. 2 to 5 insofar as the shape of the flow guidance and the shape of the sealing are concerned.

The embodiment according to Figs. 7 to 10 is designed particularly from the aspect of facilitated manipulation, optimized separating performance and cheapened manufacture. The afore-described components 1 to 30 functionally agree with those according to Figs. 1 to 6 so that the respective preceding explanation and description can be referred back to.

According to Fig. 7, the separating device is constructed as a standing appliance with vertically arranged carrier plates 1 and 2. The device according to Fig. 7 consists of a vertical end plate 27', which includes all four main connections 23 to 26 for both fluids F1 and F2, the connections ending as bores in the end plate 27'. The other end plate 28', which is without connections, is guided to be horizontally displaceable on the two lower tightening elements 21 and is supported by a central threaded spindle 33, which in turn bears against a vertical counterbearing plate 34. The plate 34 is connected through four horizintal tightening elements 21 with the end plate 27'. Both lower tightening elements 24 at the same time serve as guidance and mounting for the separating device, which is constructed as a parallelepiped or as a cassette 30 and is clamped between the two end plates 27' and 28'.

The closure plate 3' facing the end plate 28' covers the rear side, i.e. that side of the last carrier plate 1 which according to Fig. 2 or Fig. 8 is equipped with the collecting grooves 20, and is integrated with this by the sealing medium 15. The closure plate facing the connection side is constructed in two parts 3'' and 3''' and is illustrated in Figs. 9a, 9b and 10a, 10b. The closure plate parts 3'' and 3''' are integrated components of the actual separating device so that the carrier plates 1 and 2 as well as also both the closure plates 3' and 3'', 3''' form the actual cassette 30, which according to Fig. 7 is inserted in simple manner between the two end plates 27' and 28'. Guide grooves 37 in the cassette 30 provide guidance in support on both the lower tightening elements 21 and moulded-in gripping grooves 38 facilitate the manipulation of the cassette 30 during insertion between the end plates 27' and 28'. Two oppositely disposed sides of the cassette 30 have the guide

grooves 37 or the gripping grooves 38, so that the cassette 30 turned through only 180° has its correct seating, so that an erroneous insertion is prevented.

This construction has the advantage that no connections or screw connections need be released when a cassette 30 must be replaced. This is effected simply by releasing the central spindle 33.

The construction, optimized in terms of aspects of flow technique, or the carrier plate according to Figs. 8 and 8a corresponds in its functional construction to that of the carrier plate according to Figs. 2 to 5, insofar as the components 4 to 20 are concerned.

In the case of relatively large area carrier plates 1 and 2 of plastics material, the danger exists that preferred zones of flow form over the entire area of the membrane by reason of production tolerances, whereby the effectiveness of the entire membrane surface suffers. Preferably, therefore, each groove 5, with reference to Fig. 8a, has several flow barriers 31, which are distributed over the length of the groove and which end in the plane of the groove ridges 4 or thereunder, wherein each groove 5 by at least one passage 19 has a connection to a crossing collecting groove 20 of the opposite side of the carrier plate 1 or 2. The flow barriers 31 are ordered in lines 32 extending substantially parallelly to each other and obliquely to the grooves 5. In the case of an approximately square membrane surface, the longest line 32 extends at about 45° on the diagonal, whilst the remaining lines 32 are arranged at spacings parallel thereto. According to the ratio of the lengths of the sides of a rectangular membrane surface, the lines 32 cross the grooves 5 at an angle of about 30 to 60°. The lines 32 of two carrier plates 1 and 2 facing each other by their grooved sides are arranged in opposite sense, i.e. they cross each other (shown dot-dashed in Fig. 8). Under the fluid pressure of the fluid F1, a certain bowing of the membrane blanks into the supporting groove 5 occurs, which is prevented in the region of the flow barriers 31, so that a certain accumulation occurs at these places and short-circuit paths are excluded. By reason of the mutually crossing barrier lines 32 of two facing plate sides, the diagonal flow is cancelled so that a uniform flowing-over of the entire membrane surface over the entire inflow side is provided along the passages 7.

The outer outline of the carrier plates 1 and 2 differs from that of Fig. 2 through the arrangement of the guide grooves 37 on oppositely disposed outside edges and arrangement of the gripping grooves 38 also on oppositely disposed outside edges.

The two-part closure plate 3'', 3''' is also formed from plastics material and corresponds in its outer outline shape and in respect of the passages 7 and 8 to the carrier plates 1 and 2 according to Fig. 8. The rear side (not shown) of the closure plate part 3''' according to Figs. 9a, 9b is smoothly constructed and forms a cover for the uppermost carrier plate, namely the rear side thereof with the collecting grooves 20 (designated by 2TR in Fig. 2). The grooves 14 and the cross channels 13 are arranged in like manner.

According to Figs. 9a, 9b, the passages 7 and 8 are enclosed by distributing and collecting tubes 35, which are constructed to be generally trough-shaped in cross-section and form a full tube in conjunction with the trough shape, lying congruently thereover, of the distributing and collecting tubes 35 according to Fig. 10. The tubes 35 of both closure plate parts 3'' and 3''' are framed by cross channels 13' and grooves 14' and are connected to the passages 11, through which the liquid sealing medium 15 is injected into all cross channels and grooves of all plates of the cassette 30. The closure plate part 3'' corresponds in its construction on the side facing the closure plate part 3''' to this and is substantially smooth on the side facing the end plate 27'. The bores 36 arranged in the tubes 35 are aligned with the bores of the main connections 23 to 26. The bores 36 are framed, on the side facing the end plate 27', by O-ring seals which sealingly bear against the end plate 27' when the cassette 30 is pressed by the central spindle 33 against the end plate 27'.

According to the geometry of the plate configuration, formation of the flow paths and arrangement of the necessary sealing elements, it can be sufficient, or even preferable, to arrange, at least sectionwise and distributed over the plan of the carrier plates, passages 11 and 12 and channel grooves 13, 14, 13' and 14', which communicate within the plate stack so that individual sections are sealed off in common over the height of the stack. In the illustrated embodiments, the arrangement of the sealing elements is effected so that all channel grooves 13, 14, 13' and 14' and passages 11 and 12 communicate and thus all plates are sealed and durably connected one with the other together through a single injection of plastics material.

For the production of an acceptable sealing function, however, it is only necessary to use a synthetic material, for example silicone, taking over a sealing function, whilst the actual holding together of the plates to form a cassette can be effected by other mechanical tightening means.

The separating device can be used for all separating methods customary in industry, for example as a dialyser, a filter, an oxygenator, for the separation of milk content substances, for water preparation, etc., as well as for an artificial kidney or a lung in the field of medicine.

Through the arrangement of several such

parallelepipedonal separating devices 30, the total membrane area can be varied, wherein the individual separating devices 30 can be connected in series or parallel in terms of flow through the closing of slot passages of one row at the outer carrier plates 1 and 2 or through a particular construction of the closure plates 3.

CLAIMS

1. A separating device comprising a plurality of semipermeable membranes and a plurality of carrier plates retaining the membranes and defining separate flow paths for the passage of two fluids through the device each in contact with a respective one of the sides of each membrane, the plates being provided with channels in their major surfaces and with openings placing the channels of the plates in communication at least an sections, the channels and openings being filled with a solidified sealing substance sealing each flow path from the other, and being so arranged that the sealing substance is introducible in liquid state so as to solidify in situ.

2. A device as claimed in claim 1, wherein the carrier plates comprise support elements supporting the membranes and defining flow ducts of the flow paths, each membrane is sealingly connected at its edges to a respective one of the plates so as to cover the support elements thereof, the carrier plates are provided with a plurality of passages disposed outside the edges of the membranes to form distributor ducts extending normal to said membrane sides, a first plurality of the distributor ducts acting to conduct one of the fluids, and a second plurality of the distributor ducts acting to conduct the other fluid, in the respective flow paths, the plates and membranes are arranged in a stack and clamped between end cover elements, fluid inlet and outlet means in communication with the distributor ducts being provided in either or both cover elements, the sealing substance openings are disposed at spacings at at least two oppositely disposed regions of each plate, the sealing substance channels comprise cross-channels extending in the plates in at least one major surface of each plate to interconnect the openings, and grooves extending in the plates in the region of and parallel to the edges of the membranes and communicating with at least one of the cross-channels and the openings, and the sealing substance comprises at least one of a plastic material and an adhesive material which in liquid state permeates the entire stack by way of the openings and fills the cross-channels and grooves.

3. A device as claimed in claim 2, comprising a further plurality of such openings associated with the openings at said opposite regions, the further openings being distributed over the length of the cross-channels.

4. A device as claimed in claim 3, wherein each of the openings of said further plurality has a slot-shaped cross-section adapted to the shape of the respective cross-channel.

5. A device as claimed in any one of the preceding claims, wherein the plates and membranes are arranged in the form of a plurality of stack modules, the modules being permanently sealed together to form a unit.

6. A device as claimed in any one of the preceding claims, wherein the sealing substance is selected from the group consisting of polypropylene, polystyrol, polyamide, polyacetal resin, polyvinylchloride, polyethylene, polycarbonate, acrylstyrol copolymerisate and styrol-acrylnitril copolymerisate.

7. A device as claimed in any one of claims 1 to 5, wherein the sealing substance is selected from the resin group consisting of polyurethane, epoxide, urea-formaldehyde, formaldehyde melamine and formaldehyde-phenol.

8. A device as claimed in claim 1, wherein the carrier plates are substantially rectangular in shape and comprise support elements supporting the membranes and defining flow ducts of the flow paths, each membrane is substantially rectangular shape and is sealingly connected at its edges to a respective one of the plates so as to cover the support elements thereof, the carrier plates are provided with a plurality of passages disposed outside and extending parallel to the edges of the membranes and arranged in each plate along at least three of the edges thereof so as to form distributor ducts extending normal to said membrane sides, a first plurality of the distributor ducts at first and second edges of the plates acting to conduct one of the fluids into and out of the device and over the membranes and a second plurality of the distributor ducts at the remaining edge or edges of the plates acting to conduct the other fluid through said flow ducts, the plates and membranes are arranged in a stack and clamped between end cover elements, fluid inlet and outlet means in communication with the distributor ducts being provided in either or both cover elements, and said sealing substance channels and openings are so arranged that the outer regions of the plates are sealed off outwardly by seals extending around the plates and the flow paths are sealed from each other by seals disposed in the region of the membranes.

9. A device as claimed in claim 8, wherein the support elements of each plate comprise a sheet of permeable material mounted in a frame aperture of the plate.

10. A device as claimed in claim 8, wherein the support elements of each plate are provided by a plurality of ribs extending in a given direction of flow of said one fluid and the flow ducts are defined by grooves which separate the ribs, each plate being provided in the flow duct grooves with a plurality of ports

arranged at spacings along each flow duct groove and with a plurality of collecting ducts, which extend transversely to the flow duct grooves and which communicate with the ports and with the distributor ducts of said second plurality.

11. A device as claimed in claim 10, wherein each of the plates is provided in each of said flow duct grooves thereof with a plurality of flow barrier elements arranged at spacings along the respective groove and extending at most to the height of the adjoining ribs, each of the flow duct groove portions separated by the barrier elements being in communication by way of at least one of the ports with one of the collecting ducts.

12. A device as claimed in claim 11, wherein the barrier elements of each plate are arranged in parallel rows extending obliquely to the flow duct grooves.

13. A device as claimed in claim 12, wherein the barrier element rows extend at an angle of from 30 to 60° relative to the flow duct grooves.

14. A device as claimed in either claim 12 or claim 13, wherein adjacent plates are so arranged that the barrier element rows of one of the plates extend in the opposite sense to those of the other plate.

15. A device as claimed in any one of claims 8 to 14, wherein the passages forming the distributor ducts at one of the edges of each plate have an opening length of 90 to 100% of the length of the associated membrane edge.

16. A device as claimed in claim 15, wherein said first and second edges of each plate are opposite edges thereof, the distributor ducts at the first edges of the plates communicating with connection duct means for said one fluid in one of the cover elements, the distributor ducts at the second edges of the plates communicating with connection duct means for said one fluid in the other cover element, and the distributor ducts at the remaining edge or edges of the plates communicating with connection duct means for said other fluid in both cover elements.

17. A device as claimed in any one of claims 8 to 16, wherein two such carrier plates and membranes are clamped between the cover elements, the membranes being arranged adjacent to each other.

18. A device as claimed in any one of claims 8 to 16, wherein the plates and mebranes are arranged in the form of a plurality of stack modules, the modules being permanently sealed together to form a unit.

19. A device as claimed in any one of claims 8 to 18, wherein the sealing substance forms seals around said passages in the plate at one of the ends of the stack.

20. A device as claimed in any one of claims 8 to 18, comprising resilient closure elements arranged at the ends of the stack adjacent to the end carrier plates to form seals extending around said passages in the end plates.

21. A device as claimed in any one of claims 8 to 18, wherein each of the cover elements is provided with sealing means forming seals extending around said passages in the carrier plates at the ends of the stack.

22. A device as claimed in any one of claims 8 to 21, wherein the sealing substance openings are disposed at spacing at at least two oppositely disposed corner regions of each plate, and the sealing substance channels comprise cross-channels extending in the plates in at least one major surface of each plate to interconnect the openings, and grooves extending in the plates in the region of and parallel to the edges of the membranes and communicating with at least one of the cross-channels and the openings, the sealing substance comprising at least one of a plastics material and an adhesive material which in liquid state permeates the entire stack by way of the openings and fills the cross-channels and grooves.

23. A device as claimed in claim 22, comprising a further plurality of such openings associated with the openings at said opposite corner regions, the further openings being distributed over the length of the cross-channels.

24. A device as claimed in any one of claims 8 to 23, wherein the fluid inlet and outlet means are provided in a first one of the cover elements and the second cover element acts as a clamping pressure plate displaceable relative to the first cover element along connecting elements, the second cover element beng urged against the stack of plates and membranes by an adjusting spindle mounted in a counterbearing member.

25. A device as claimed in claim 24, comprising a respective closure element which is arranged between the second cover element and the adjacent end of the stack and which corresponds in outline shape to that of each carrier plate, the closure plate being sealed to said adjacent stack end by the sealing substance.

26. A device as claimed in either claim 24 or claim 25, comprising a respective closure element arranged between the first cover element and the adjacent end of the stack, sealed to the stack end by the sealing substance, and provided in the region of said passages of the plates with distributing and collecting ducts and with inlet and outlet bores, which communicate with the distributing and collecting ducts and with said fluid inlet and outlet means, resilient annular sealing means being arranged between the first cover element and adjcent closure element to seal the transition between the inlet and outlet bores and said fluid inlet and outlet means.

27. A separating device substantially as

hereinbefore described with reference to Figs. 1 to 5, Fig. 6, Figs. 8 and 8a or Figs. 7, 9a, 9b, 10a and 10b of the accompanying drawings.

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